

# 2013 BJCP Exam Study Group

## Class 3: Hops

<http://destroy.net/brewing/BJCP-SFHG-2013-hops.pdf>



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# BJCP Exam Study- Hops - Outline

- Prerequisites: 2012 BJCP Study Guide and 2008 BJCP style guidelines.
- Introduction
- BJCP Beer Judge Entrance Exam hop perspective
  - Focus on why and how (for both history and process)
  - Important hop varieties for the BJCP exam program.
  - Sensory perception language.
- Summary & Hops beyond the BJCP exam.



# BJCP Exam Study- Hops - Introduction

- What are/is....
  - hops and why are they relevant to brewing?
  - the active ingredients in hops?
  - the history of hops in beer?
  - the different varieties of hops?
- How are..
  - Hops cultivated and what do they look like?
  - hops used in the brewing process?



## BJCP Hops – Introduction

- What are hops and why are they relevant to brewing?
  - Female flowers of the humulus lupulus plant.
    - Vine-like dioecious perennial.
      - *Dioecius: separate male/female plants*
    - Long climbing bine with dark green leaves. (13)
      - *Bine vs vine? trichomes instead of tendrils. (13)*
    - Thought to have originated in China (13)
    - Member of the cannabaceae plant family, related to hemp, marijuana, nettles and hackberry. (1,13)
    - 1 crop yield per year, dormant phase necessary during the non-productive season.

# Hop fields. Yakima, WA.





# BJCP Hops – Introduction

- Primary benefits of hop use in brewing:
  - **Taste:** Alpha acids are a bittering agent to balance sweetness, hops also provide distinctive flavor compounds.
  - **Aroma:** Spicy, fruity, herbal, earthy complexity.
  - **Longevity:** Preservative. Hops have a bacteriostatic effect against gram-positive bacteria. (9)
  - **Visual:** Head retention.
  - **Process:** Kettle coagulation, wort filtration, protein precipitation. (11)
- Potential drawbacks:
  - **Light Sensitivity**
  - **Haze**
  - **Polyphenols**
  - **Astringency**



# BJCP Hops - Introduction

## Hop Cultivation

- Commercial Hop Growing (6,7)
  - Hops grow best in hot, dry climate between 30-52 degrees North/South. (13)
    - Yakima, WA, 46 degrees N. Nelson, New Zealand, 41 degrees S.
    - Hallertau, Germany, 49 degrees N. Kent, UK, 51 degrees N.
- Worldwide production (6,7)
  - 1992: 236k acres worldwide. 2006: 113k acres.
  - USA: 30k acres, Germany: 40k acres.
    - USA: 70% Yakima, WA. 15% Oregon, 15% Idaho.
  - 70% of worldwide crop is high alpha for extract production. (6,7)

# Hops during the growing season



2.5 months, clockwise climbing trellis. At peak, up to 20 inches per week.



2.5 months, vegetative growth, dark green leaves.



# Hops during the growing season

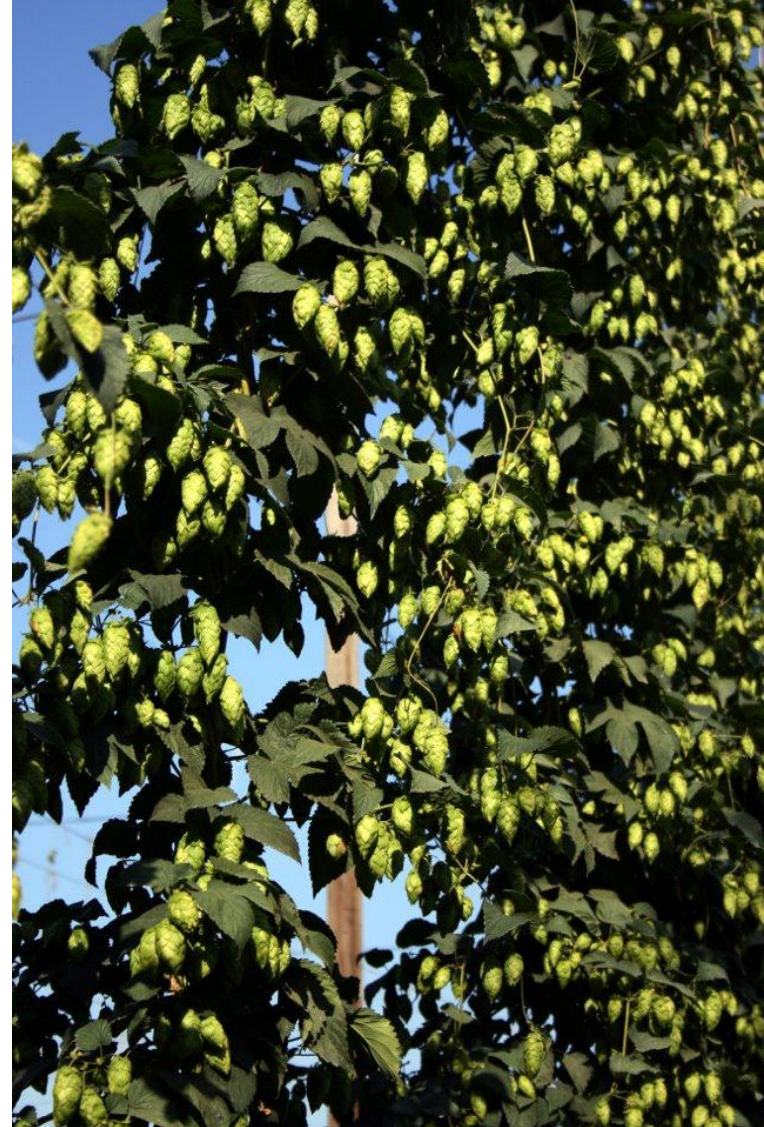


3.5 months, Cascade flowers starting



4 months, Cascade flowers maturing.

# Hops at harvest



# Hops at harvest





# BJCP - Hops Introduction - History

- What is the history of hops in beer?
  - Most recent addition of the 4 common ingredients.
  - Gruit before hops, combination of herbs/spices.
  - First written documentation in the west:
    - Gaius Plinius Secundus aka. Pliny the Elder (61-113 AD). Discusses hops in his study of natural history. To the Romans, it was *Lupus Salictartius*, from the way they originally grew. As the ancients said, hops grew "wild among willows, like a wolf among sheep," *Lupulus* derived from the Latin *lupus* (wolf). (9)
    - Modern scientific name, *Humulus Lupulus* coined by Swedish botanist Carl Linne (Linnaeus) in 1753 by joining the two terms (14):
      - *Humulus*/humle/humli = Swedish term for hop.
      - *Lupulus* = Latin word for hop coined by Pliny the Elder.



# BJCP - Hops Introduction - History

- First recorded...
  - Harvesting: 768AD, Hallertau region (13)
  - Use in beer: 822AD, Abbott Adelhard, Benedictine Monestary of Corby in the Picardy, northeastern France. (13)
  - Preservative qualities: 1150-1160 in Physica, Abbess Hildegard of St. Rupertsberg first documented preservative effects. (14)
- German acceptance 1500s, documented in the 1516 purity law, the Reinheitsgebot. (1)
- Introduced into British Isles from Holland in 1500s.
  - They were not well accepted under Henry VIII and were not in widespread use until the 1600s. (1)
  - By the 1700s.. Hodgson's India Ale hopped at a rate of 10.5oz. Per US 5 gallons, approximately 70 ounces per US barrel (3.5 lb per). (4)



# BJCP Hops – Intro

Active Ingredients:  $\alpha$  &  $\beta$  acids

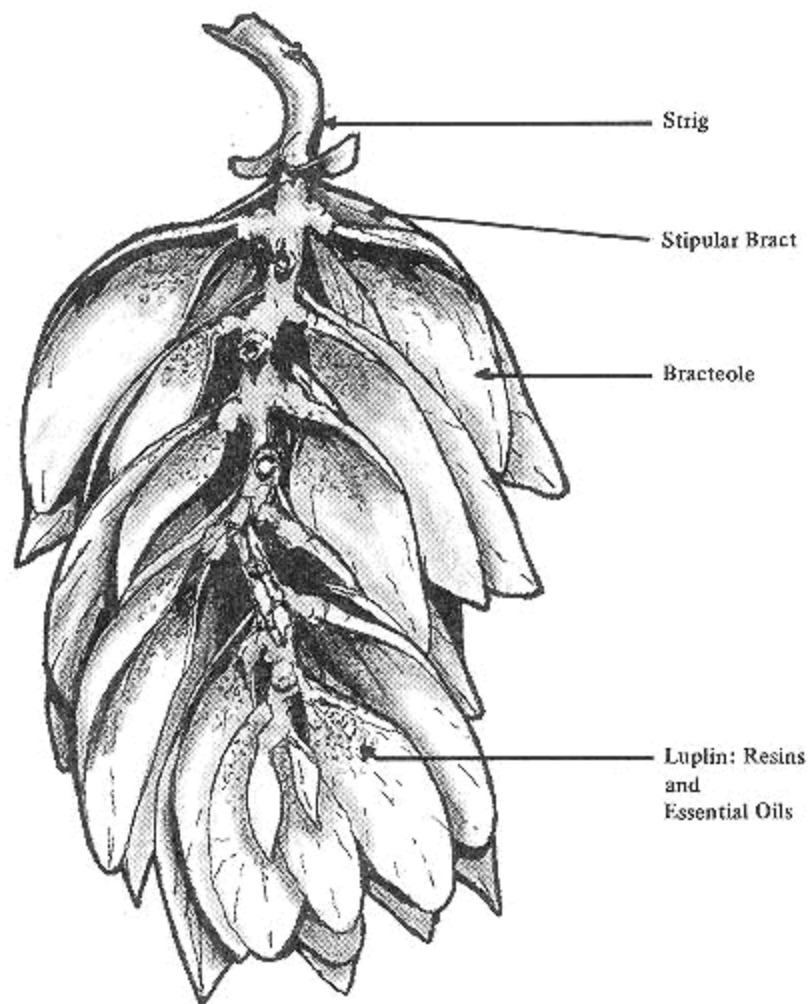
- What are the active ingredients in hops?
  - Soft resins found in the lupulin gland of the flower.
- $\alpha$  &  $\beta$  acids. Bacteriostatic against gram+ bacteria. (1)
- $\alpha$  acids: primary humulone, also cohumulone, adhumulone.
  - Total  $\alpha$  acid content ranges from 2-20%.
  - Cohumulone, humulone – 15-50% each. Variety specific. (11)
  - Adhumulone – 15%. (11)
  - High cohumulone: can provide harsh bitterness, lower foam stability. (13)
- $\beta$  acids: lupulone, colupulone, adlupulone. (11)
  - Most sought after hops have 1:1  $\alpha$ : $\beta$ . Worldwide crop majority 2:1.



# BJCP Hops – Intro Hop flower Profile



Mature hop flower, profile, split in half, displaying lupulin glands. (8)





# BJCP Hops – Intro

## Active Ingredients: essential oils

- Essential oils
  - Responsible for distinct hop aroma.
  - ~.5-3% volume by weight. Extremely volatile.
  - Can increase perceived bitterness & enhance mouth feel. (11)
  - 80% hydrocarbons. Primarily: (11, 13)
    - Humulene: woody, balsamic.
    - Carophyllene: black-pepper spicy.
    - Myrcene: Geranium-like floral.
    - Farsenene: Gardenia-like floral. (less frequent)
    - Linalool: Citrus-like bergamot. (least frequent, but high impact)
  - Remainder oxygenated sulfur containing hydrocarbons. (11)





# BJCP - Hops Introduction

## Hop Acids

- Soft Resins ( $\alpha$ & $\beta$ ) extracted by boiling. each contribute bitterness.
- $\alpha$  acids isomerized into iso-alpha acids/iso-humulones during boil. Chemical structure re-arranged into a more stable form. (13)
- Approximately 25-30% alpha acids utilized during a typical bittering charge in a 60-90 minute boil.
- Extraction influenced by density of wort and length of boil.
- $\beta$  acids are poorly soluble in wort and contribute only about 10% of bittering. (11)
- $\beta$  acids Higher bacteriostatic effect than  $\alpha$  acids. (9)
- Highly oxidized  $\beta$  acids can have a spoiled vegetal taste. (11)



# BJCP - Hops Introduction

## Varieties

- ~100 varieties of hops are available commercially.
  - Varieties change quickly, ex: Cluster original American hop
    - 70% of all U.S. hops grown/used in 1978. Very small percentage now.
- Key varieties for BJCP exam: Noble hops and signature varieties for hop forward styles.
- Noble hops are the most ancient land races of hops.
  - German Tettnang
  - German Hallertau Mittelfruh
  - German Spalt
  - Czech Saaz *\*country designations important!*
- Noble hop common traits:
  - Flavor & Aroma: spicy and floral
  - Low alpha acid %, nearly equal beta acid.
  - Low myrcene content, low cohumulone content and high humulene content.
  - Notoriously low yielding (can be 3:1 lower), disease prone, store poorly. (13)



# BJCP - Hops Introduction

## Varieties important for BJCP exam

Name	Alpha Acid %	Flavor and Aroma	Associated Styles
Cascade	4.5-7	Flowery, citrusy, grapefruit & pine (13)	American ales
Centennial	9.5-11.5	Floral, citrus, lime	American ales
Chinook	12-14	Spicy, piney, grapefruit. (13)	American ales
Fuggle	4-5.5	Earthy, woody, geraniol, fruity	British ales
Hallertau Muttelfrueh	3-5.5	Complex slightly herbal, pleasant, mild. Aged: cedar, leather, tobacco(13)	German lagers
Kent Golding	4-7	Gentle, fragrant, earthy, fruity, geraniol	British ales
Czech Saaz	3-5	Mild, slightly spicy, herbal, flowery	Bohemian Pilsner
German Spalt	4-5	Delicate Spicy, pleasant, mild, slightly flowery/gardenia. (13)	German lagers, ales
German Tettnanger	3.5-5.5	Delicate Spicy, pleasant, mild, slightly citrus/grassy (13)	German lagers, ales
U.S. Northern Brewer	6-10	Woody, Minty	California Common



# BJCP - Hops Introduction

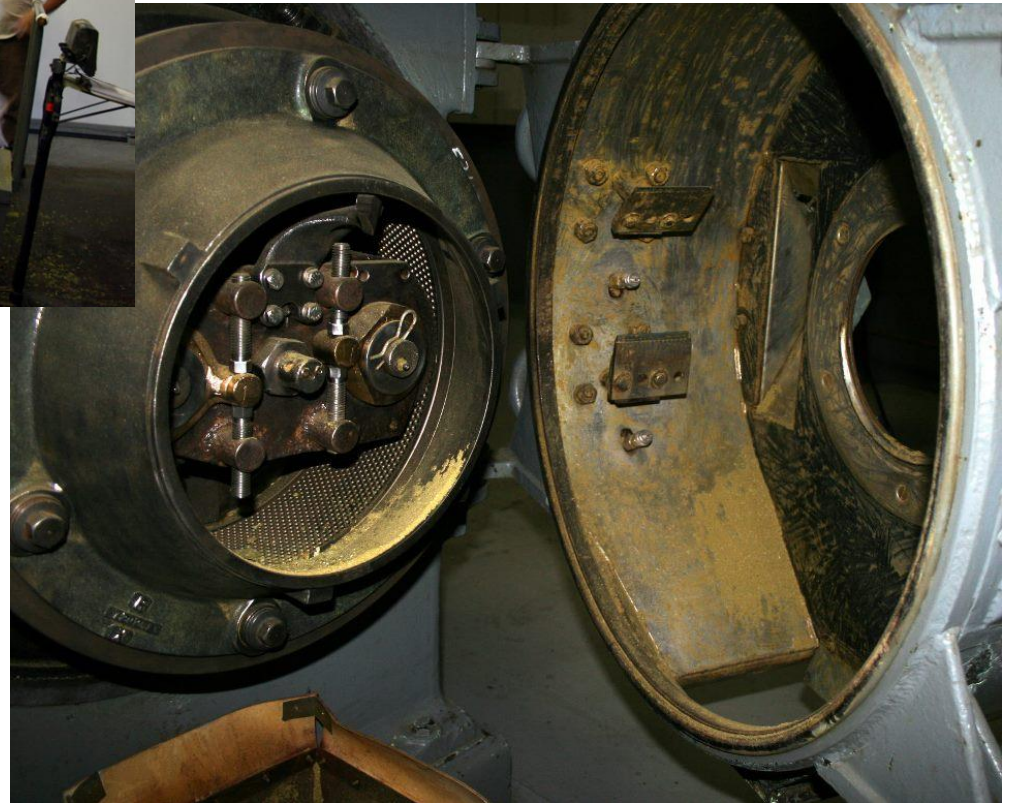
## Brewing Process: hop formats

- Hop formats: Whole flower, pellets, plugs. All start as kiln-dried flowers. Each has different storage and utilization characteristics.
- Whole Flowers: Unruptured lupulin glands, most perishable, bulky storage.
  - Some brewers insist on them. Sierra Nevada is one example.
  - Higher quantity of vegetative matter = lower batch efficiency.
  - Often have lower kettle utilization than pellet hops, up to 25% less (10).
  - Soft, even, gentle extraction of acids & oils over a longer period of time. (5)

# Hop processing



# Hop processing





# BJCP - Hops Introduction

## Brewing Process: hop formats

- Pellets: Ruptured lupulin glands, most stable, space-efficient storage.
  - Direct, more immediate, “in your face” dissolution of acids & oils. (5)
  - T90 pellets: Powderized whole flowers at a 90% recovery of whole flowers by weight.
  - T45 pellets: Powderized lupulin glands with vegetal material separated mechanically from resins/oils at -35 degrees C. 45% recovery of whole flowers by weight. (7).
- Plugs: Compressed flowers. .5oz units. Designed for British cask ales. (11).
- Extremely perishable product. Freshness is important for all styles with 1 big exception.



# BJCP - Hops Introduction

## Brewing Process

- Brewers commonly add hops at 4 possible times during the brewing process: At 60, 30 and 0 minutes left in the boil and post fermentation (dry hopping).
- All have different effects on hop bitterness, flavor and aroma in the finished beer and not all beers will utilize each addition point.

Boil time, min.	Bitterness contribution	Flavor contribution	Aroma Contribution
60	High	Low	None
30	Low	Moderate	Moderate
0	None	Low	High
Dry Hop	None	Low	Highest





# BJCP - Hops Introduction

## Measuring bitterness: IBU

- Percentage of bittering extracted from hops into a finished beer is commonly referred to as IBU, International Bitterness Units. (1 IBU = 1ppm, or 1 mg per Liter)

$$IBU = \frac{(W \times U \times A \times 7,489)}{(V \times C)}$$

- W = Weight in ounces
- U = Utilization in percent
  - Example values: 20% for 30 minutes, 27% for 60 minutes, 34% for 90 minutes.
- A = Alpha acids in percent
- V = Volume in gallons
- C = Gravity correction factor  $1 + \frac{[gravity - 1.060]}{.2}$  (10)
  - To simplify matters, assume it is 1 for hand calculations.
- 7489 = Constant value used to convert from gallons and ounces to parts per million
- Example calculation: 1 oz Fuggles hops, 5% AA boiled for 60 minutes, 5gal., 1.050 OG.
  - $IBU = [1 * 0.27 * 0.05 * 7489] / 5 = 20.22$



# BJCP - Hops Introduction

## Measuring bitterness: IBU

- American Light Lager: 8-12IBU, close to flavor threshold. Some English pale ales can have up to 45IBU in a beer starting at the same original gravity as the American Light Lager. (10)
- Measured IBU level does not always translate to the perceived bitterness. (1)
- Higher gravity wort can lower kettle utilization as much as 15%. (10)
- The ionic makeup of the brewing water, particularly carbonate and sulfate levels, directly affects the perception of bitterness. (11)
- Any post-fermentation filtering, fining, centrifuging can also lower measured IBU and/or perceived bitterness. (10)



# BJCP Exam – Hops

## BJCP Sensory Perception Language

- Flavor/aroma/appearance/mouthfeel, good and bad
- Acceptable flavors/appearances, within a range:
  - Bitterness - isomerized hops.
  - Cloudiness/haziness - hop polyphenols, acceptable in some styles (14C, Imperial IPA for example.)
  - Grassiness - appropriate in small levels in some styles: American Pale ale, all of category 14 (IPA). possible source=over dry hopping, hop varieties (Cascade).
  - Head retention - high alpha acid hops can help contribute to good head retention.
- Off flavors/aromas/mouthfeel, always:
  - Cheesiness (isovaleric) - oxidized, old hops.
  - Skunkiness/lightstruck - Ultraviolet light reacting with isomerized hop alpha acids.
  - Astringency - excessive hopping can be a source.



# Summary & Hops beyond the BJCP exam.

- Stan Hieronymus “For The Love of Hops”, Mitch Steele “IPA: Brewing Techniques..”
- New high alpha cultivars have a common lineage:
  - BB1: Obtained in 1916 rhizome taken from a wild hop in Morden, Manitoba.
  - Brewer’s Gold → Crossed with other hops: Magnum, Chinook, Centennial, Nugget Horizon.
- Yakima Chief, Hopunion, USDA variety databooks and websites.
- Newer cultivars with ancestry and characteristics of common hop varieties.
  - Santiam: Tettnang, Sterling: Saaz, Mt. Hood: Hallertau, Willamette: Fuggle.
- Other tasting ideas:
  - Orval to highlight Styrian Goldings in balance with esters and brett.
  - La Rulles Tripel or Houblon Chouffe to show American Hops in a Belgian Ale.
  - Single hop beers at Triple Rock, Bistro IPA festivals, hop varieties listed.

# BJCP Exam Preparation: Hops

## Credits and References

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# BJCP Exam Preparation: Hops

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